(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
10 May 2001 (10.05.2001)

PCT

(10) International Publication Number
WO 01/33823 A1

(51) International Patent Classification[7]: H04M 3/30, H04B 3/46

(21) International Application Number: PCT/IB00/01550

(22) International Filing Date: 26 October 2000 (26.10.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
99/6943 4 November 1999 (04.11.1999) ZA
99/7016 9 November 1999 (09.11.1999) ZA

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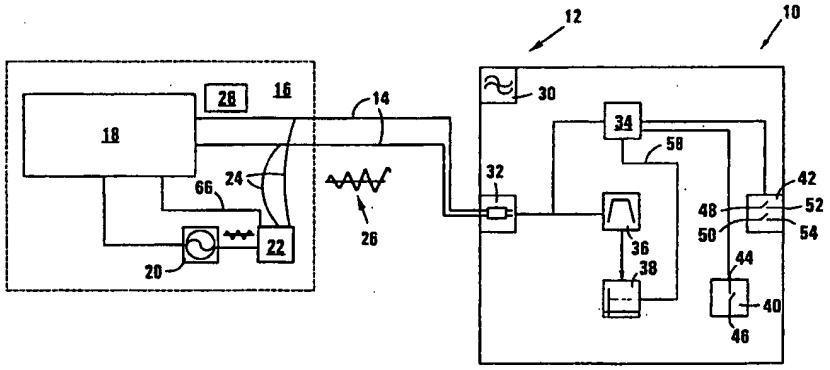
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *With international search report.*
— *Before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: SUBSCRIBER LINE TEST SYSTEM



(57) Abstract: A system for testing a telecommunication line is provided. The system includes acentral unit, at least one remote unit and threshold detection means. The central unit (16) includes signal generation means (20) capable of generating a test signal (26) of increasing amplitude or frequency and is operatively connected to an exchange end of the line. The central unit further includes comparator means connected to the signal generation means. The remote unit is connected in use to a subscriber unit end of the line and is operable under control of the central unit selectively to disconnect the subscriber unit. The threshold detection means (38) detects when the test signal reaches a predetermined threshold and, in response thereto, the comparator means compares the predetermined threshold with the amplitude of the test signal applied to the line when the predetermined threshold is reached. From the comparison line attenuation may be determined.

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SUBSCRIBER LINE TEST SYSTEM

THIS INVENTION relates to telecommunications. It relates in particular to a system for, and method of, testing a telecommunication line. It also relates to a slave device and to central testing apparatus for use in the system and method.

According to the invention, there is provided a system for testing a telecommunication line, the system including

a central unit including

signal generation means capable of generating a test signal of increasing amplitude or frequency, the signal generation means being operatively connected to an exchange end of the line;

comparator means connected to the signal generation means;

at least one remote unit connectable to a subscriber unit end of the line, the remote unit being operable under control of the central unit selectively to disconnect the subscriber unit; and

threshold detection means for detecting when the test signal reaches a predetermined threshold and, in response thereto, the comparator means compares the predetermined threshold with the amplitude of the test signal applied to the line when the predetermined threshold is reached.

Preferably, the central unit includes line connection means for progressively connecting the signal generation means to a plurality of lines in an automated fashion thereby to test a plurality of lines.

In order to facilitate use of the device in the field, the system may include a portable housing in which the central unit is mounted. In certain embodiments of the invention, the threshold detection means is provided in the central unit and connected in a series configuration. However, in other embodiments, the threshold detection means is provided in the remote unit.

The remote unit may include a controller, typically a microprocessor based controller, for controlling operation of the unit and shorting means connected to the subscriber unit end of the line. The controller may be responsive to the threshold detection means and, when the predetermined threshold is reached, the controller may be operable to activate the shorting means to short-circuit the line in response to which the comparator means compares the predetermined threshold with the amplitude of the test signal applied to the line.

In more sophisticated embodiments of the invention, the test signal is of a set frequency and of increasing amplitude, the threshold detection means including filter means for filtering the test signal received by the threshold detection means. The test signal is typically a sine wave signal, the actual frequency of the signal differing in various different applications.

Preferably, the filter means is an adjustable filter operable to adjust its filtering characteristics under control of the controller. For example, the filter may be a bandpass filter and the controller may be operable to adjust its centre frequency upon command from the central unit.

The signal generation means may be operable selectively to generate a plurality of test signals at different frequencies and the controller may adjust the centre frequency of the filter to correspond to the frequency of the particular test signal.

Advantageously, the remote device may include a power supply unit which sources power from the telecommunication line and powers circuitry of the remote device.

The remote unit may include a subscriber line interface circuit capable of protecting the subscriber unit. In addition or instead, the system may include switching means operable selectively to connect and to disconnect the subscriber unit and the threshold detection means to and from the line.

Further in accordance with the invention, there is provided a method of testing a telecommunication line, the method including

applying a test signal of increasing amplitude or frequency to the line;

sensing when the amplitude of the test signal reaches a predetermined threshold; and

comparing the predetermined threshold and the amplitude of the test signal applied to the line when the predetermined threshold is reached.

The method may include applying the test signal progressively in an automated fashion to a plurality of lines thereby to test the plurality of lines one at a time.

In certain circumstances, the predetermined threshold is sensed at a subscriber unit end of the line. In other circumstances, the predetermined threshold is sensed at an exchange end of the line.

The method may include shorting a subscriber unit end of the line when the predetermined threshold is reached to trigger the comparison between the predetermined threshold and the amplitude of the test signal applied to the line.

The method may include applying a test signal of a set frequency and increasing amplitude to the line. Preferably, the method includes applying a plurality of test signals at different frequencies and adjusting a centre frequency of a filter at the subscriber unit end of the line and sensing when the predetermined threshold is reached at each different frequency.

Still further in accordance with the invention, there is provided a slave device which includes a remote unit including

connection means connectable to a subscriber unit and to a subscriber unit end of a telecommunication line, the connection means

being operable under control of a central unit selectively to disconnect the subscriber unit from the line; and

threshold detection means for detecting when a test signal applied to the line at the central unit reaches a predetermined threshold at the subscriber unit end, the threshold detection means being operable to communicate that the predetermined threshold has been reached to the central unit.

The remote unit may include a controller for controlling operation of the unit and shorting means connected to the subscriber unit end of the line. The controller may be responsive to the threshold detection means and, when the predetermined threshold is reached, the controller may be operable to activate the shorting means to short-circuit the line in response to which comparator means at the exchange end of the line compares the predetermined threshold with the amplitude of the test signal applied to the line.

The test signal is typically of a set frequency and of increasing amplitude, the threshold detection means including filter means for filtering the test signal fed into the threshold detection means.

The filter means is preferably an adjustable filter operable to adjust its filtering characteristics under control of the controller. The filter may be a bandpass filter and the controller may be operable to adjust its centre frequency upon command from the central unit.

In certain embodiments, the remote device includes a power supply unit which sources power from the telecommunication line and powers circuitry of the remote device.

The remote unit may include a subscriber line interface circuit capable of protecting the subscriber unit. Further, the slave unit may include switching means operable selectively to connect and to disconnect the subscriber unit and the threshold detection means to and from the line.

Still further in accordance with the invention, there is provided central testing apparatus for testing at least one telecommunication line, the apparatus being connectable to an exchange end of the line and including a central unit including

control means for controlling operation of a slave device operatively connected to a subscriber unit end of the line;

signal generation means capable of applying a test signal of increasing amplitude or frequency to the line; and

comparator means to compare the amplitude of the test signal applied to the line with the predetermined threshold when the predetermined threshold is detected by the slave unit.

The central unit may include line connection means for progressively connecting the signal generation means to a plurality of lines in an automated fashion thereby to test a plurality of lines. The apparatus may include a portable housing in which the central unit is mounted.

The apparatus typically includes sensing means for sensing when the line is shorted and, in response thereto, the comparator means compares the predetermined threshold with the amplitude of the test signal.

The signal generation means may be operable selectively to generate a plurality of test signals at different frequencies and provide an instruction signal to the slave device to adjust a centre frequency of its filter to correspond to the frequency of the particular test signal.

It is to be appreciated that for the purposes of this specification the term "slave device" is intended to include so-called maintenance termination units (MTUs), or the like.

The invention is now described, by way of example, with reference to the accompanying diagrammatic drawings.

In the drawings,

Figure 1 shows a schematic block diagram of a slave device in accordance with the invention;

Figure 2 shows a schematic block diagram of a system, also in accordance with the invention, which includes the slave device of Figure 1;

Figure 3 shows a schematic block diagram of a further embodiment of the system, in accordance with the invention, which includes a threshold detector located in a central unit of the system;

Figure 4 shows a schematic equivalent circuit of the system of Figure 3;

Figure 5 shows a schematic flow chart of operations carried out by the central unit;

Figure 6 shows a schematic flow chart of operations carried out by the slave device of Figure 1;

Figure 7 shows a schematic block diagram of a yet further embodiment of the system, also in accordance with the invention, for testing a telecommunication line;

Figure 8 shows a graphic representation of a test signal applied to the line by a central unit of the system;

Figure 9 shows a graphic representation of the test signal received at a slave unit or MTU of the system of Figure 7;

Figure 10 shows a graphic representation of the normalised loss on the telecommunication line; and

Figure 11 shows an equivalent circuit of the telecommunication line.

Referring to the drawings, reference numeral 10 generally indicates a slave device in accordance with the invention. The device 10 forms part of a system 12 (see Figure 2), also in accordance with the invention, for testing attenuation on a telecommunication line 14. The system 12 further includes a central unit 16 which is typically connected at an exchange end of the line 14. As described in more detail below, the system 12 is operable to perform maintenance tests on the telecommunication line 14 in a single ended testing fashion.

The central unit 16 includes a remote test unit (RTU) 18, a signal generator 20, and a variable gain amplifier 22 connected via lines 24 to the telecommunication line 14. In use, the signal generator 20 and

the variable gain amplifier 22 generate a test signal 26 which is sequentially applied to a plurality of telecommunication lines by means of a switching arrangement 28 thereby sequentially to test the lines.

Each telecommunication line 14 connected to the central unit 16 includes a slave device 10 which is serially connected to customer premises equipment (CPE) such as a subscriber telephone unit or the like. The device 10 includes a power supply unit 30, a subscriber line interface circuit or SLIC 32, a microprocessor based controller 34, filter means in the form of a bandpass filter 36, a threshold detector 38, a short circuit switch 40, and CPE disconnect switches 42.

Contacts 44, 46 of the short circuit switch 40, and contacts 48, 50 of the CPE disconnect switches 42 are connected to the telecommunication line 14. Contacts 52, 54 of the CPE disconnect switches 42 are connected to the subscriber telephone unit. The CPE disconnect switches 42 selectively connect and disconnect the customer premises equipment or subscriber unit to the line 14 on command from the central unit 16.

The subscriber line interface circuit or SLIC 32 provides protection to customer premises equipment and to the slave device 10 against voltage surges, lightning spikes, or the like. Optionally, the SLIC 32 also matches the impedance of the various components of the device 10 to the line 14.

Referring in particular to Figure 3 of the drawings, reference numeral 12.1 generally indicates a further embodiment of a system, in

accordance with the invention, for testing the telecommunication line 14. The system 12.1 substantially resembles the system 12 and, accordingly, like reference numerals have been used to indicate the same or similar features unless otherwise indicated.

The main difference between the system 12.1 and the system 12, is that the threshold detector 38 is not provided in the slave device 10.1 but rather in the central unit 16.1. Further, the central unit 16.1 includes a microprocessor 56 which is connected to the threshold detector 38 via line 58. As described in more detail below, during operation of the systems 12 and 12.1, the RTU 18 instructs the microprocessors 34 and 56 respectively to monitor the threshold detector 38 to ascertain when the predetermined threshold is reached. Further, once the predetermined threshold is reached, the microprocessors 34 and 56 instruct the RTU accordingly.

Referring in particular to Figure 5 of the drawings, reference numeral 60 generally indicates a schematic flow chart of various functions or operations performed by the central unit 16, 16.1. As mentioned above, the central unit 16, 16.1 is operable sequentially to test or perform prequalification tests on a plurality of different telecommunication lines 14. Initially, the RTU 18 awaits a request for prequalification testing as shown at block 62. If no test request is received, the system loops as shown at line 64 until a request is received.

If, however, a request for testing of a particular telecommunication line 14 is received, as shown at block 66, the central

unit 16, 16.1 applies an instruction signal on the telecommunication line 14 to which the slave device 10, 10.1 is responsive. In particular, the instruction signal is fed into the device 10, 10.1 via the SLIC 32 and, upon receipt of the instruction signal, the microprocessor 34 switches the CPE disconnect switches 42 thereby to disconnect any customer premises equipment from the line 14. Thereafter, the RTU 18 selects a first frequency at which the line 14 is to be tested.

Operation of the System 12

In the system 12, the RTU 18 instructs the frequency generator 20 to generate a test signal at the particular frequency and also sends a frequency instruction signal along the line 14 to which the device 10 is responsive. In particular, upon receipt of the frequency instruction signal, the controller 34 adjusts a centre frequency of the bandpass filter 36 thereby to filter out any signals not at the particular selected frequency. The signal 26 which is sourced from the signal generator 20 and progressively amplified by the variable gain amplifier 22, is applied to the line 14 and therefore received by the slave device 10. The test signal 26 is fed through the bandpass signal 36 to the threshold detector 38 to monitor the amplitude of the test signal 26. When the test signal 26, after a period of time, has reached the predetermined threshold of the threshold detector 38, the event is detected by the controller 34 as shown by line 58. The controller 34 then activates the short circuit switch 40 which, accordingly, short-circuits the line 14. The central unit 16 detects that the line has in fact been shorted and measures the particular amplitude of the test signal 26 at which the short circuit switch 40 was triggered. The RTU 18, which is connected via line 66 to the

variable gain amplifier 22, then calculates line attenuation by comparing the amplitude of the test signal transmitted with the predetermined threshold of the threshold detector 38. For example, the loss along the line 14 may be calculated as follows:

$$dB_{loss} = -10Log_{10} \frac{\text{Amplitude of test signal x } A_{VG}}{\text{Predetermined threshold}}$$

Once the test signal 26 at a particular frequency with an increasing amplitude has been applied to the line 14, a timer is started as shown at block 70 (see Figure 5). If the duration of the timer has lapsed (see block 72), then the test procedure is terminated as shown at 74. If, however, the timeout duration has not lapsed, then the threshold detector 38 monitors to ascertain whether or not the predetermined threshold has been reached as shown at block 76. If the predetermined threshold has been reached, the RTU 18 obtains the gain (A_{VG}) of the variable gain amplifier 22 via line 66 as shown at block 78. Thereafter, the RTU 18 calculates the attenuation as described above and shown at block 80. The selected frequency is then incremented by the RTU 18 and the signal generator 20 is then instructed to generate the next frequency as shown at block 82. The aforementioned procedure is followed until the different frequencies have been tested as shown at block 84 whereafter the test procedure is terminated as shown at 86.

Referring in particular to Figure 6 of the drawings, reference numeral 90 generally indicates a schematic flow chart of various functions or operations performed by the slave device 10, 10.1. As shown at block 92, the device 10 enters a wait cycle until a

prequalification test request signal is received from the central unit 16. Upon receipt of a request signal the CPE is disconnected (see block 94). Thereafter, upon receipt of a frequency instruction signal from the central unit 16, the centre frequency of the filter 36 is changed as shown at block 100. The test signal is then monitored to ascertain when the predetermined threshold is reached as shown at block 108. Once the threshold is reached, as described above, line 14 is shorted by the short circuit switch 40 as shown at block 110. Thereafter, upon receipt of a further frequency instruction signal from the central unit 16, the centre frequency of the filter 36 is changed as shown at block 100. The test signal is continuously monitored to ascertain whether or not the predetermined threshold has been reached as shown at block 108 and, if not, any other valid instructions received from the central unit 16, are processed as shown at block 104.

As shown at block 106, a timer is started and, if a threshold has been reached as shown at block 108, the short circuit switch 40 is activated as shown at block 110. As shown at block 112, the duration of the timer is monitored and, if the predetermined time has lapsed, the consumer premises equipment is reconnected as shown at block 114.

Operation of the System 12.1

The system 12.1 operates substantially in the same manner as the system 12 except that, as the threshold detector 38 is located in the central unit 16.1, its operation is not controlled via the line 14. The line 14 merely controls the CPE switches 42 and the short circuit switch 40 via the controller 34 located in the slave device 10.1. The threshold

detector 38 detects when the predetermined threshold is reached and the microprocessor 56 instructs the RTU 18 accordingly.

Referring in particular to Figures 7 to 10 of the drawings, reference numeral 12.2 generally indicates a further embodiment of a system, in accordance with the invention, for testing a telecommunication line 14. The system 12.2 resembles the systems 12, 12.1 and, accordingly, like reference numerals have been used to indicate the same or similar features.

The system 12.2 includes a central unit 16.2 including a RTU 18 and a signal generator 20. Unlike the signal generator 20 of the systems 12, 12.1 which generate a test signal 26 of increasing amplitude, the signal generator 20 of the system 12.2 generates a test signal 120 (see Figure 8) of constant amplitude but of increasing frequency. The slave unit or device 10.2 substantially resembles the slave device 10 but does not include the bandpass filter 26. It preferably also includes a power supply unit 30.

When testing telecommunication lines with the system 12.2, a switching arrangement (not shown) selectively connects the line 14 to the RTU 18 and the signal generator 20. The test signal 120 is then applied to the line 14. Due to the filter effect of the line 14 (see equivalent circuit of the line 14 as shown in Figure 11), the signal is progressively attenuated as the frequency of the test signal 120 is increased (see Figures 9 and 10). When the signal received by the slave device 10.2 reaches or drops to a predetermined low value, the threshold detector 38 triggers the controller 34 to short the line 14 by means of

the short circuit switch 40. The shorted line is then detected by the central unit 16.2 and the attenuation in the line 14 is determined as set out above with reference to the systems 12, 12.1.

It is believed that the time required to test the line 14 may be reduced by the system 12.2. In particular, instead of applying a multitude of different test signals each of a particular frequency and increasing amplitude, a single test signal 120 of constant amplitude and increasing frequency is applied thereby reducing testing time especially when a large number of lines are to be tested. Further, unlike the system 12, the system 12.2 does not include a variable gain amplifier 22 in the central unit 16.2 and a bandpass filter 36 in the slave device 10.2 thereby reducing manufacturing costs of the central unit 16.2 and the slave device 10.2.

It is believed that the invention, as illustrated, provides an enhanced system 12, 12.1, 12.2 for testing the telecommunication line 14.

CLAIMS :

1. A system for testing a telecommunication line, the system including

a central unit including

signal generation means capable of generating a test signal of increasing amplitude or frequency, the signal generation means being operatively connected to an exchange end of the line; and

comparator means connected to the signal generation means;

at least one remote unit connectable to a subscriber unit end of the line, the remote unit being operable under control of the central unit selectively to disconnect the subscriber unit; and

threshold detection means for detecting when the test signal reaches a predetermined threshold and, in response thereto, the comparator means compares the predetermined threshold with the amplitude of the test signal applied to the line when the predetermined threshold is reached.

2. A system as claimed in Claim 1, in which the central unit includes line connection means for progressively connecting the signal generation means to a plurality of lines in an automated fashion thereby to test a plurality of lines.

3. A system as claimed in Claim 1 or Claim 2, which includes a portable housing in which the central unit is mounted.

4. A system as claimed in any one of the preceding claims, in which the threshold detection means is provided in the central unit.

5. A system as claimed in any one of the preceding claims 1 to 3 inclusive, in which the threshold detection means is provided in the remote unit.

6. A system as claimed in any one of the preceding claims, in which the remote unit includes a controller for controlling operation of the unit and shorting means connected to the subscriber unit end of the line, the controller being responsive to the threshold detection means and, when the predetermined threshold is reached, the controller being operable to activate the shorting means to short-circuit the line in response to which the comparator means compares the predetermined threshold with the amplitude of the test signal applied to the line.

7. A system as claimed in any one of the preceding claims, in which the test signal is of a set frequency and of increasing amplitude, the threshold detection means including filter means for filtering the test signal received by the threshold detection means.

8. A system as claimed in any one of the preceding claims, in which the test signal is a sine wave signal.

9. A system as claimed in Claim 7 or Claim 8, in which the filter means is an adjustable filter operable to adjust its filtering characteristics under control of the controller.

10. A system as claimed in Claim 9, in which the filter is a bandpass filter and the controller is operable to adjust its centre frequency upon command from the central unit.

11. A system as claimed in any one of the preceding claims 6 to 10 inclusive, in which the signal generation means is operable selectively to generate a plurality of test signals at different frequencies and the controller adjusts the centre frequency of the filter to correspond to the frequency of the particular test signal.

12. A system as claimed in any one of the preceding claims, in which the remote device includes a power supply unit which sources power from the telecommunication line and powers circuitry of the remote device.

13. A system as claimed in any one of the preceding claims, in which the remote unit includes a subscriber line interface circuit capable of protecting the subscriber unit.

14. A system as claimed in any one of the preceding claims, which includes switching means operable selectively to connect and to disconnect the subscriber unit and the threshold detection means to and from the line.

15. A method of testing a telecommunication line, the method including

applying a test signal of increasing amplitude or frequency to the line;

sensing when the amplitude of the test signal reaches a predetermined threshold; and

comparing the predetermined threshold and the amplitude of the test signal applied to the line when the predetermined threshold is reached.

16. A method as claimed in Claim 15, which includes applying the test signal progressively in an automated fashion to a plurality of lines thereby to test the plurality of lines one at a time.

17. A method as claimed in Claim 15 or Claim 16, in which the predetermined threshold is sensed at a subscriber unit end of the line.

18. A method as claimed in Claim 15 or Claim 16, in which the predetermined threshold is sensed at an exchange end of the line.

19. A method as claimed in any one of the preceding claims 15 to 18 inclusive, which includes shorting a subscriber unit end of the line when the predetermined threshold is reached to trigger the comparison between the predetermined threshold and the amplitude of the test signal applied to the line.

20. A method as claimed in any one of the preceding claims 15 to 19 inclusive, which includes applying a test signal of a set frequency and increasing amplitude to the line.

21. A method as claimed in 15 to 19 inclusive, which includes applying a plurality of test signals at different frequencies and adjusting a centre frequency of a filter at the subscriber unit end of the line and

sensing when the predetermined threshold is reached at each different frequency.

22. A slave device which includes a remote unit including

connection means connectable to a subscriber unit and to a subscriber unit end of a telecommunication line, the connection means being operable under control of a central unit selectively to disconnect the subscriber unit from the line; and

threshold detection means for detecting when a test signal applied to the line at the central unit reaches a predetermined threshold at the subscriber unit end, the threshold detection means being operable to communicate that the predetermined threshold has been reached to the central unit.

23. A slave unit as claimed in Claim 22, in which the remote unit includes a controller for controlling operation of the unit and shorting means connected to the subscriber unit end of the line, the controller being responsive to the threshold detection means and, when the predetermined threshold is reached, the controller being operable to activate the shorting means to short-circuit the line in response to which comparator means at the exchange end of the line compares the predetermined threshold with the amplitude of the test signal applied to the line.

24. A slave unit as claimed in Claim 22 or Claim 23, in which the test signal is of a set frequency and of increasing amplitude, the threshold detection means including filter means for filtering the test signal fed into the threshold detection means.

25. A slave unit as claimed in Claim 24, in which the filter means is an adjustable filter operable to adjust its filtering characteristics under control of the controller.

26. A slave unit as claimed in Claim 25, in which the filter is a bandpass filter and the controller is operable to adjust its centre frequency upon command from the central unit.

27. A slave unit as claimed in any one of the preceding claims 22 to 26 inclusive, in which the remote device includes a power supply unit which sources power from the telecommunication line and powers circuitry of the remote device.

28. A slave unit as claimed in any one of the preceding claims 22 to 27, in which the remote unit includes a subscriber line interface circuit capable of protecting the subscriber unit.

29. A slave unit as claimed in any one of the preceding claims 22 to 28, which includes switching means operable selectively to connect and to disconnect the subscriber unit and the threshold detection means to and from the line.

30. Central testing apparatus for testing at least one telecommunication line, the apparatus being connectable to an exchange end of the line and including a central unit including

control means for controlling operation of a slave device operatively connected to a subscriber unit end of the line;

signal generation means capable of applying a test signal of increasing amplitude or frequency to the line; and

comparator means to compare the amplitude of the test signal applied to the line with the predetermined threshold when the predetermined threshold is detected by the slave unit.

31. Apparatus as claimed in Claim 30, in which the central unit includes line connection means for progressively connecting the signal generation means to a plurality of lines in an automated fashion thereby to test a plurality of lines.

32. Apparatus as claimed in Claim 30 or Claim 31, which includes a portable housing in which the central unit is mounted.

33. Apparatus as claimed in any one of the preceding claims 30 to 32, which includes sensing means for sensing when the line is shorted and, in response thereto, the comparator means compares the predetermined threshold with the amplitude of the test signal.

34. Apparatus as claimed in Claim 33, in which the signal generation means is operable selectively to generate a plurality of test signals at different frequencies and provide an instruction signal to the slave device to adjust a centre frequency of its filter to correspond to the frequency of the particular test signal.

35. A new system, substantially as herein described and illustrated.

36. A new slave device, substantially as herein described and illustrated.

37. New central testing apparatus, substantially as herein described and illustrated.

38. A new method of testing a telecommunication line.

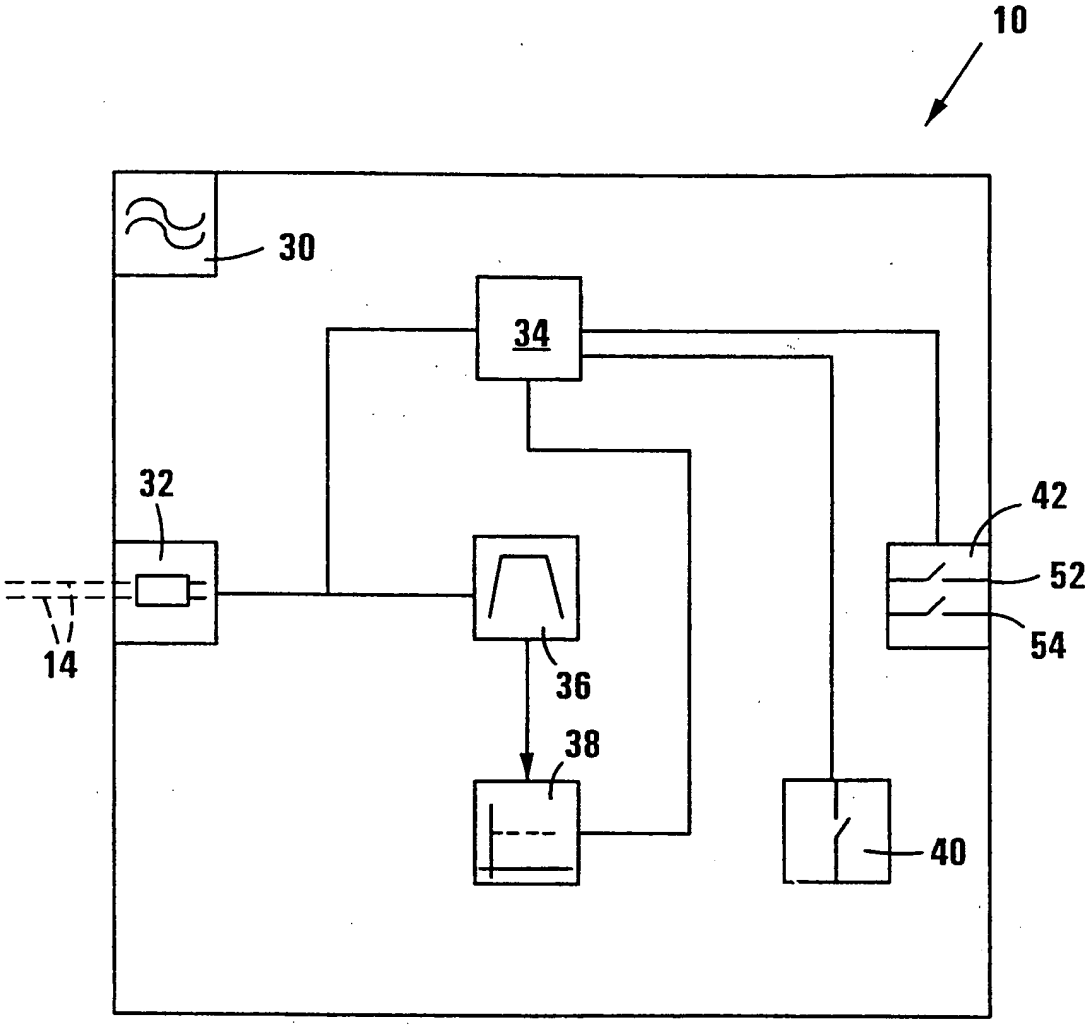

FIG 1

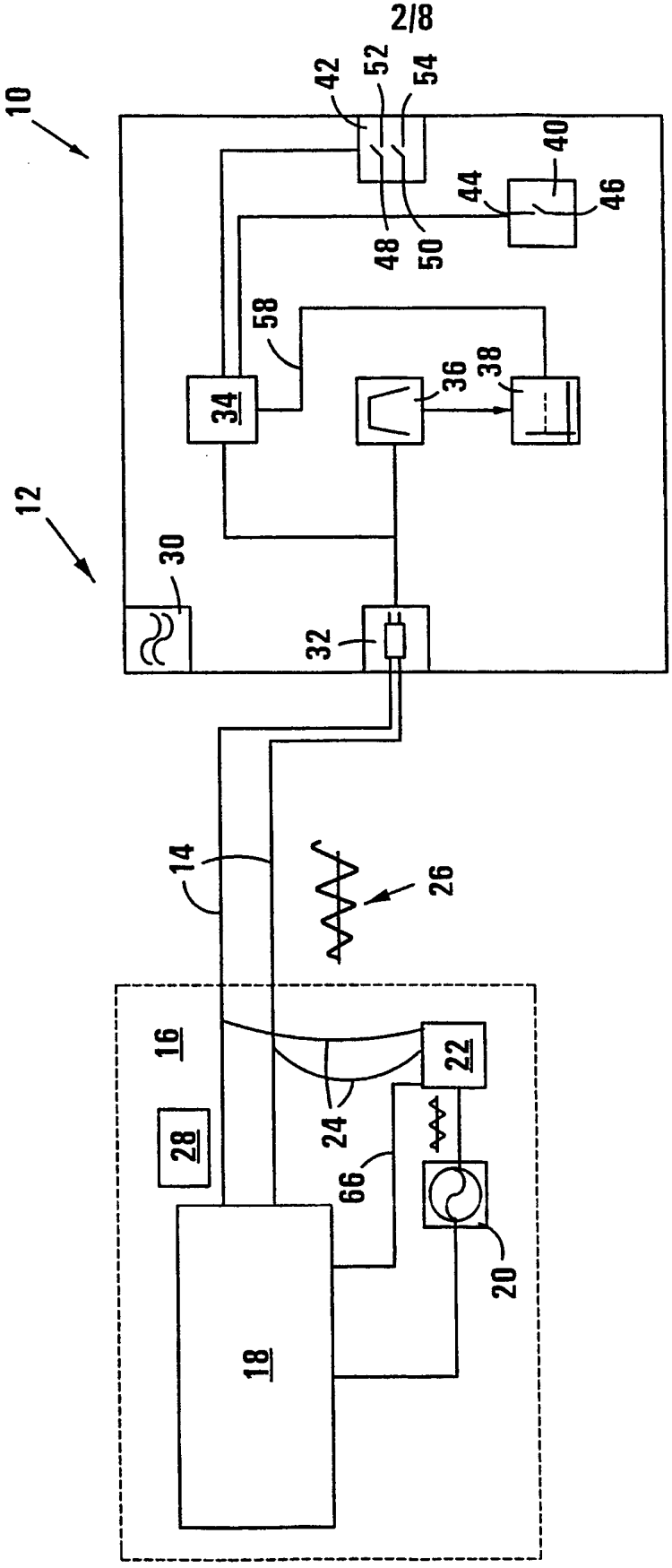
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FIG 2

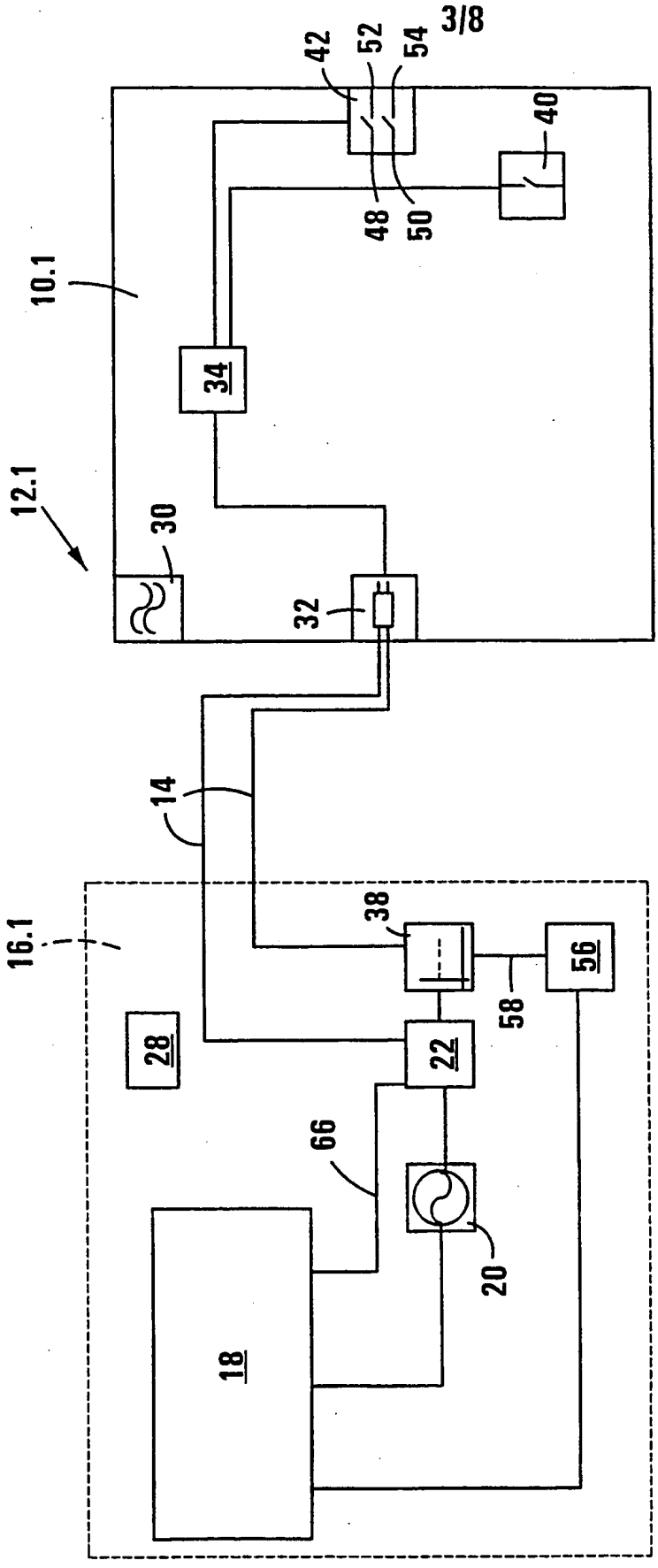

FIG 3

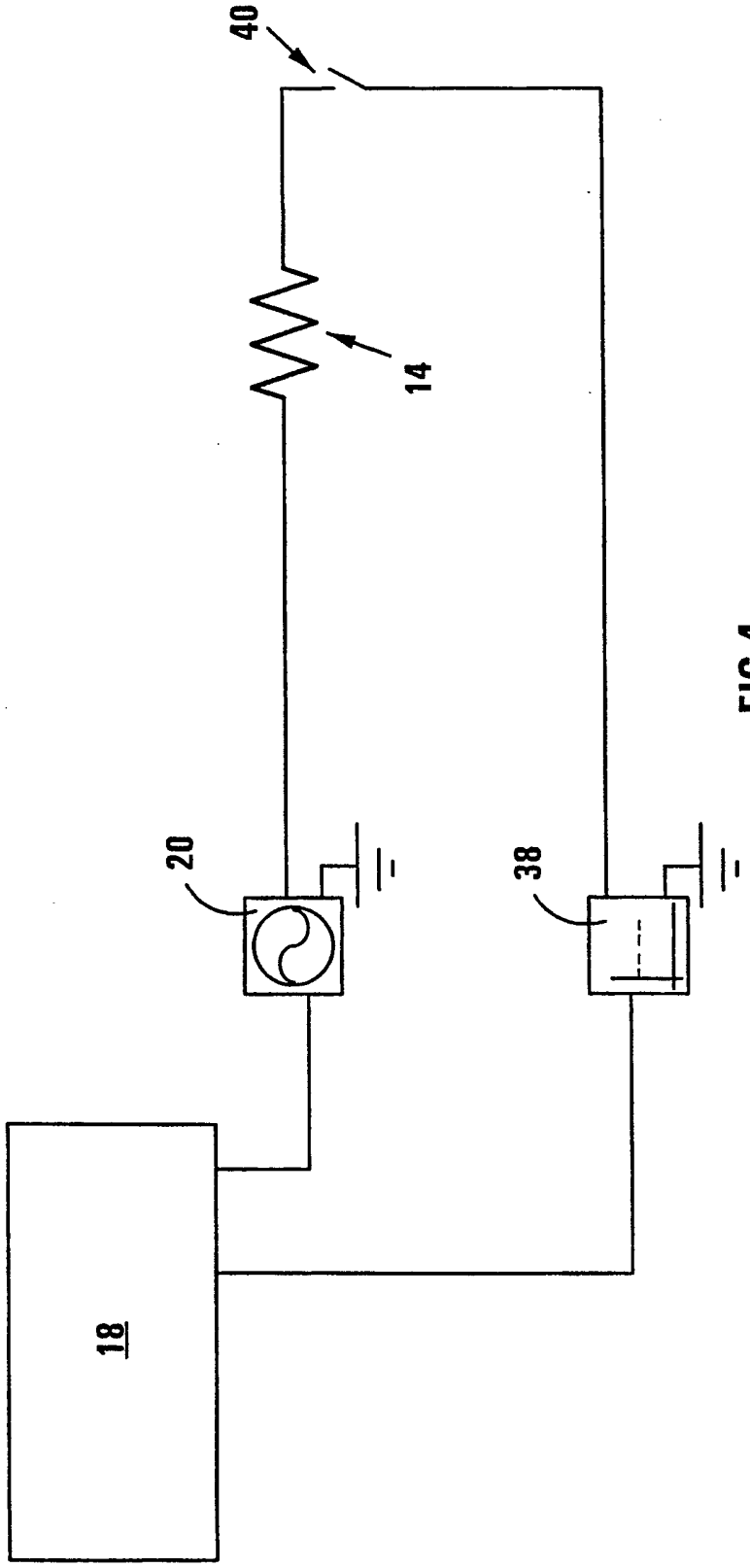

FIG 4

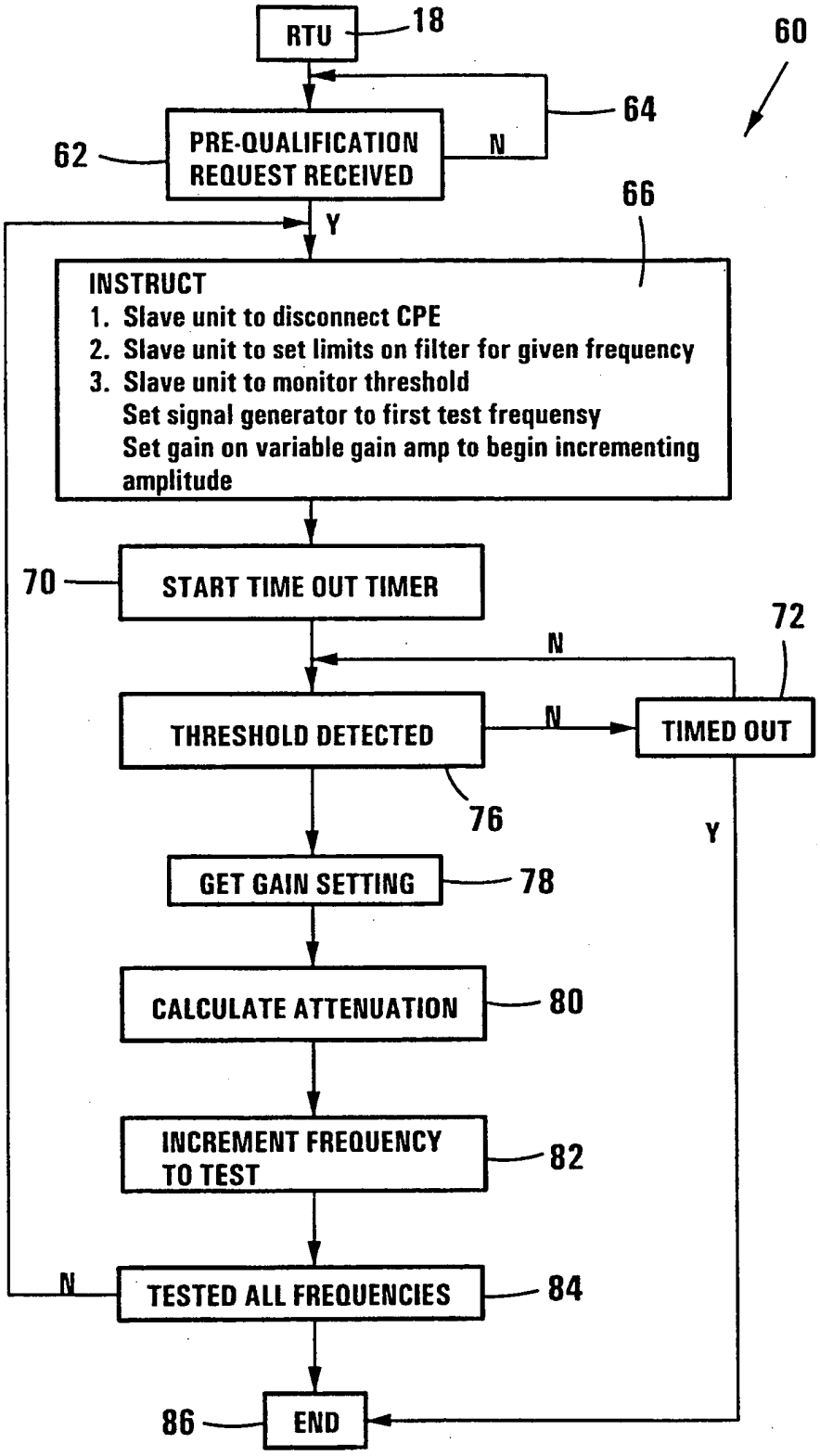

FIG 5

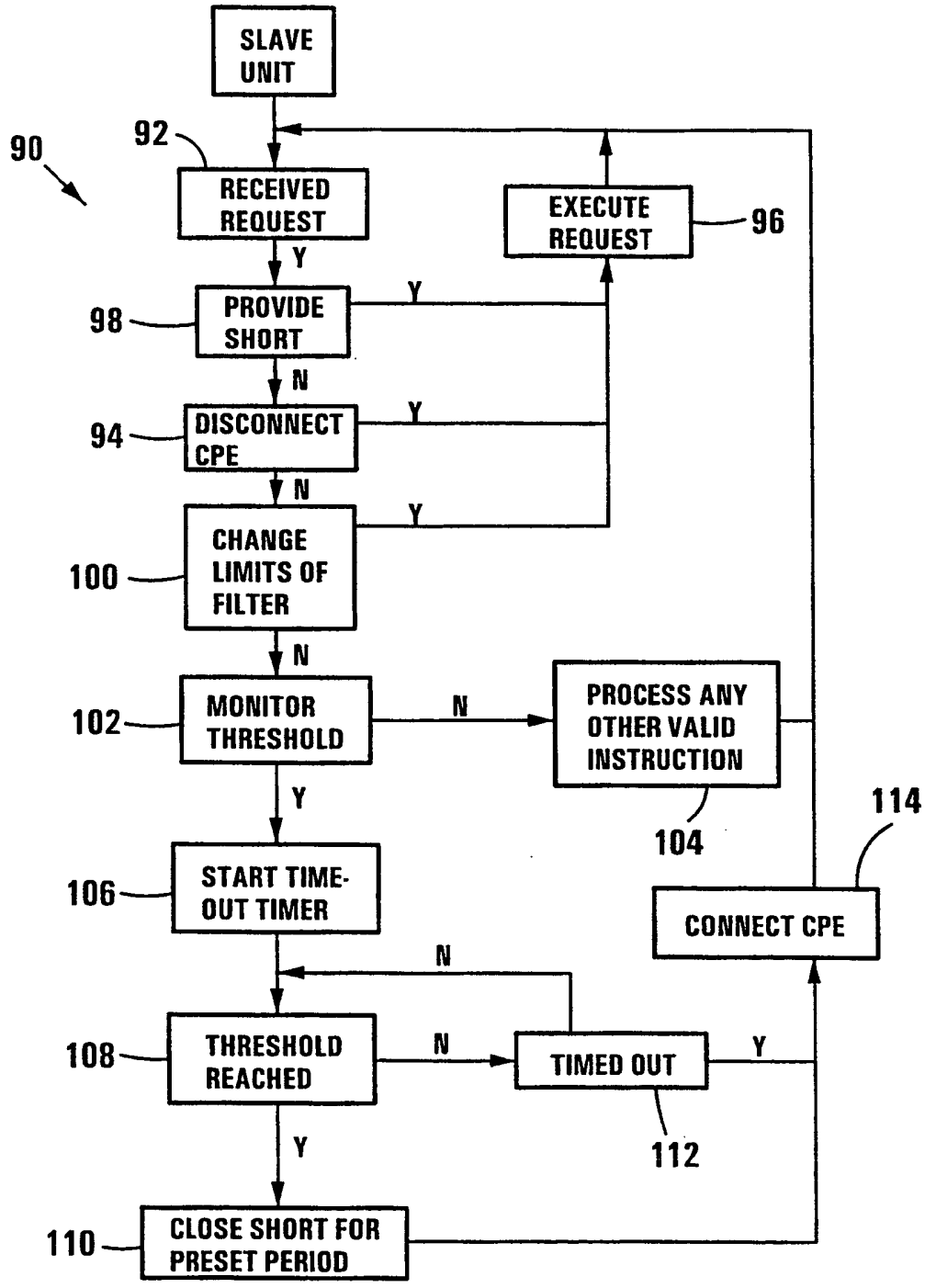
SLAVE UNIT
90
92
RECEIVED REQUEST
Y
EXECUTE REQUEST
96
98
PROVIDE SHORT
Y
N
94
DISCONNECT CPE
Y
N
100
CHANGE LIMITS OF FILTER
Y
N
102
MONITOR THRESHOLD
N
PROCESS ANY OTHER VALID INSTRUCTION
104
Y
114
106
START TIME-OUT TIMER
CONNECT CPE
N
108
THRESHOLD REACHED
N
TIMED OUT
Y
112
Y
110
CLOSE SHORT FOR PRESET PERIOD

FIG 6

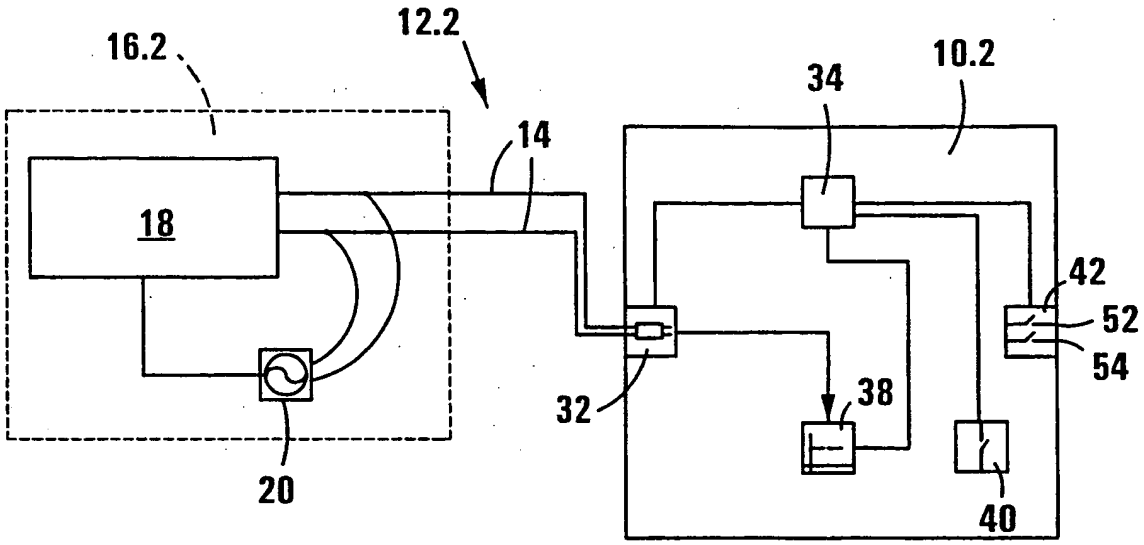

FIG 7

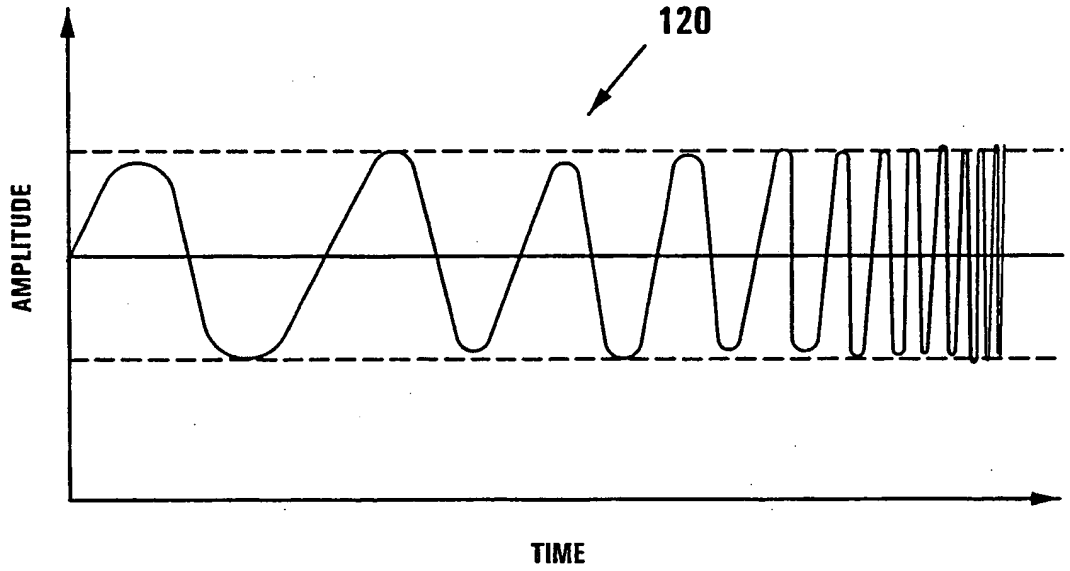

FIG 8

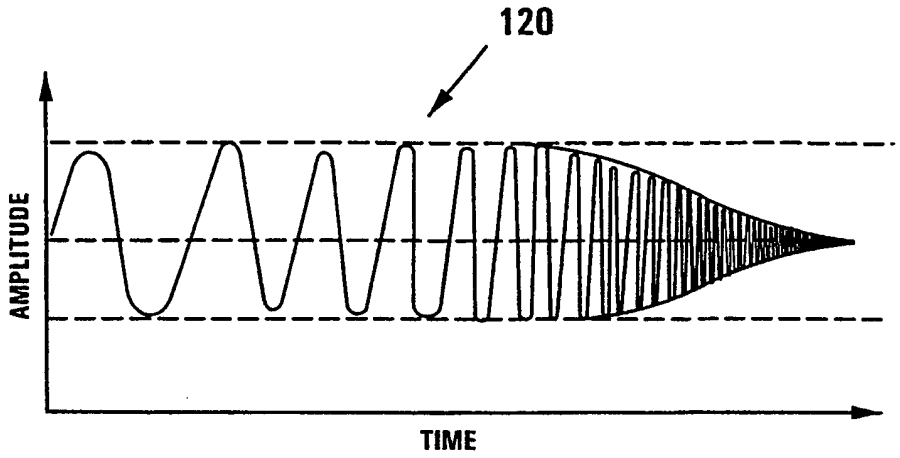

FIG 9

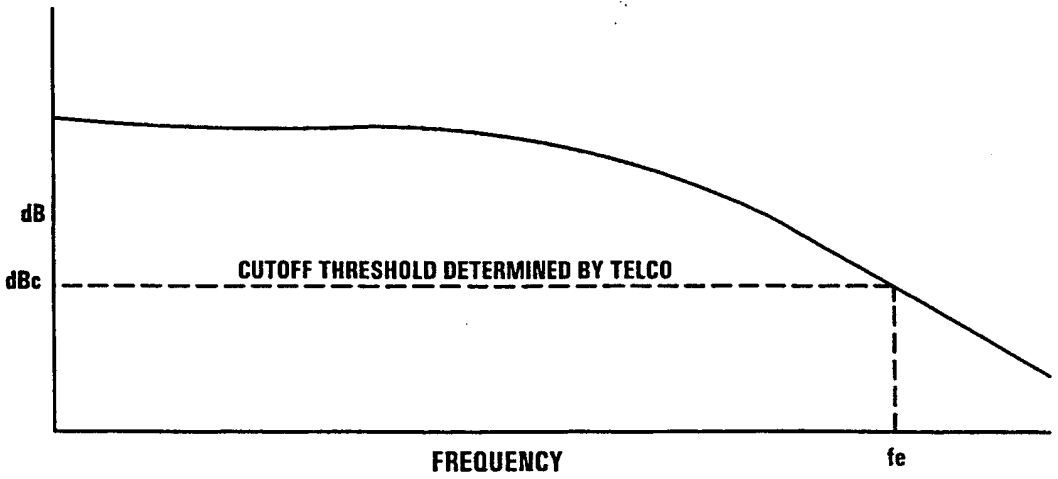

FIG 10

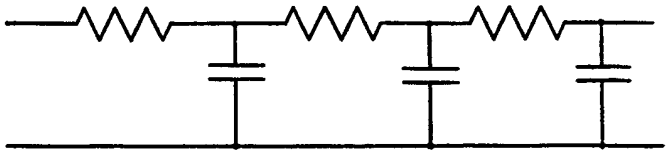

FIG 11

INTERNATIONAL SEARCH REPORT

Intern. nal Application No
PCT/IB 00/01550

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04M3/30 H04B3/46

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04M H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 661 776 A (CHARLAND CLAUDE) 26 August 1997 (1997-08-26) column 2, line 25 - line 41	1-38
A	US 4 815 119 A (MILLS BERNARD S E) 21 March 1989 (1989-03-21) column 2, line 1 - line 39	1-38
A	US 5 402 073 A (ROSS ALAN) 28 March 1995 (1995-03-28) abstract	1-38

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

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"E" eartier document but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
5 April 2001	17/04/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Schweitz, M

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INTERNATIONAL SEARCH REPORT

Intern. nal Application No
PCT/IB 00/01550

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	TAMIO MOTOMITSU ET AL: "DEVELOPMENT OF CENTRALIZED LOOPTESTING SYSTEM FOR SUBSCRIBER LOOPS" NTT REVIEW,JP,TELECOMMUNICATIONS ASSOCIATION, TOKYO, vol. 3, no. 1, 1991, pages 117-121, XP000223906 the whole document	1-38

1

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Intern nal Application No
PCT/IB 00/01550

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